2010 NASA AERONAUTICS COMPETITION

The Amphibious Tiltrotor

By:

Craig Copeland grade 12

Jordan Gibson grade 12

Linwood Holton Governor's School

One Partnership Circle, PO Box 1987

Abingdon, VA 24212

School End Date: June 1, 2010

Instructor: Dr. Steve Rapp

[Personal Information Redacted]

[Personal Information Redacted]

[Personal Information Redacted]

Amphibious Tilt rotor for Rescue Operations

Tragic events happen on a daily basis, leaving numerous lives at stake. Vast tornadoes destroy innocent lives and wipe out everything in their path. Random earthquakes abruptly shatter the earth's crust damaging people's homes and sadly leaving them stranded beneath the debris. Also, distressed ships at sea are left abandoned in the eye of a hurricane. What's more, fires can consume a life's worth of savings in a matter of minutes, leaving behind only ashes to account for all they have worked for. The inability to predict what will happen often results in misfortune. All over the world people are crying out, asking for a hand in the time of distress. Rotorcrafts are that helpful hand. When all hope seems lost, brave men and women aboard rotorcrafts put their lives on the line in order to give others hope. Members of the National Guard follow closely behind the wake of a category F-5 tornado to assist in search-and-rescue efforts (Woods, MilitaryConnections.com). The U.S. Navy aircraft vehicles send over a hundred thousand pounds of food, water, and medical supplies daily to areas of need after the destruction of an earthquake (West, AviationToday.com). The Coast Guard is humbled to say they have saved thousands from treacherous waters. Through these efforts rotorcraft has

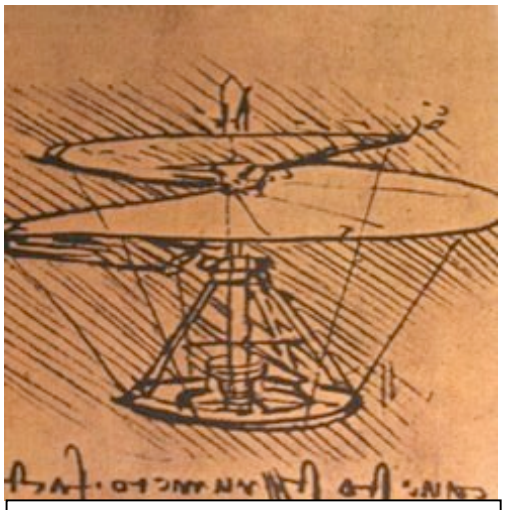
Destruction after a tornado hit Hallam, Nebraska in May of 2004 <http://www.nebraskaweatherphotos.org/hallam-disappears1.html>.

unmistakably made their presence known in the relief and aid of others. Without the technology of aeronautic development and research, a great mass of civilians would not have been as fortunate. Sadly, there are some that still never escape the catastrophic events and disasters due to the limits of what rotorcraft can accomplish, so far. That is where the future of rotorcraft technology comes in. With competitive research, innovative minds, and a yearning desire to expand the competence of aircraft, members of the Fundamental Aeronautics Program hope to develop a safer, more reliable form of aircraft (National Aeronautics and Space Administration, Aeronautics.nasa.gov). Many professionals believe that the future of rotorcraft technology will be realized with the invention of the amphibious tilt rotor. Their potential capabilities would include landing on water, taking off into flight from water, carrying a maximum of 50 passengers as well as traveling at a velocity of 300kts. How is this possible? Engineers have invented most all the modern day technologies that are in place today, that were merely thoughts decades ago. The mind of an engineer is truly without limits. With the development of an amphibious tilt rotor, our nation would be more secure and would allow for rescue missions to be accomplished at a much faster pace.

A 3-Dimesional view of the possible design of the future tilt rotor, known as the AgustaWestland Merlin Mark 3+ <http://navy-matters.beedall.com/frc.htm>.

Webster's dictionary defines rotorcraft as an aircraft whose lift is derived principally from rotating airfoils (Rotorcraft, Merriam-Webster.com). An assembly of blades provides lift

to a particular form of aircraft, such as a helicopter. It's not to be confused with the 'other half' of aviation, the airplane. Rotorcrafts are an interestingly unique form of aircraft that many people consider fascinating. While airplanes are required to stay in constant motion, rotorcrafts can hover above ground and remain idle due to the steady spin of rotor blades. Massive airplanes are without a doubt limited to areas they can operate. However, rotorcrafts can maneuver themselves into the most constricted areas, as well as linger inches above ground, only to propel in the air again at an impressive rate of climb. Strong winds that hinder other forms of aviation are trivial to a good pilot's handling skills abroad a rotorcraft. They have the equivalent of high wind loading thanks to the small-chord rotor blades doing the work of a larger-chord fixed wing.



The Aerial Screw design by Leonardo da Vinci in the early 15th century <http://allegoryofhistory.blogspot.com/2009/03/artists-depiction-aerial-screw-and-da.html>.

Ideas for the first rotor operated vehicle can be traced back as early as the 15th century. The great Italian inventor, Leonardo da Vinci designed an 'aerial screw' made of iron wire and covered with linen that resembled a helicopter (Rumerman, CentennialofFlight.gov). Unfortunately, his plans were not discovered until the early 20th century. Da Vinci planned to use human strength to gyrate the blades, thus propelling the vehicle. Though he undoubtedly established the foundation of rotorcraft, his ideas proved to be irrational. Many other inventions came to light between the 15th and 20th century and all played a major role in the advancement of creating the first rotorcraft. Before the Wright brothers flew the world's first airplane, Igor Sikorsky was constructing the first coaxial helicopter in Russia (Air Scooter Cooperation, AirScooter.com). Other famous names that also had a hand in coaxial

helicopters include: Cornu, Asboth, Pescara, De Bothezat, Berliner, Bendix, and Hiller (Air Scooter Cooperation , AirScooter.com). All of these great inventors were still lacking a key component in rotorcraft technology: knowledge of the nature of lift and a sufficient motor (Air Scooter Cooperation, AirScooter.com). The invention of the internal combustion engine changed everything. With this new found knowledge, engineers were able to develop a full-scale replica with an ample power source. Finally, on one groundbreaking spring day, Igor Sikorsky assembled the first helicopter known to man (Rumerman, CentennialofFlight.gov).

Rotorcraft could be divided into three different classes: helicopters, autogyros, and gyrodynes. The helicopter is a type of rotorcraft the flies on a single or multiple rotors. The rotors allow it to fly forward, backwards, and even laterally. The second class of rotorcraft is the autogyros. What makes an autogyro different from a helicopter is simply the lack of a powered rotor. After gaining speed, the aircraft is lifted off the ground, and the rotor blades 'automatically begin rotating. It is then pulled through the air by a separate attached propeller. The autogyro achieved moderate success in the United States but proved to be very popular in foreign parts of the world such as Britain, Germany, and Russia.

The Gyrodyne QH-50 takes off of a U.S. Navy assault ship <https://www.vtol.org/uavpaper/NavyUAV.htm>.

The last class, which is the most advance form of rotorcraft to-date, is the gyrodyne. The gyrodyne is very similar to the helicopter only it has the assistance of one or more propellers mounted wings adjoined to either side. Less power is required of the rotor thanks to the extra

'push' from the propellers. The rotor only receives enough power sufficient to keep the aircraft above ground, thus, making the gyrodyne the most efficient form of rotorcraft as well.

Regardless of the class it is assigned, rotorcrafts have undoubtedly made their presence known in the world of aviation, and a positive one I might add. Whether they are helping fight fires, or rescuing men, women and children in the midst of natural disaster, rotorcraft helps save multiple lives every day. The military has been utilizing the helicopter since the latter part of World War II (Sikorsky Archives, SikorskyArchives.com). After the USS Turner exploded just off of Sandy Hook, New Jersey, the Coast Guard sent plasma to the injured crewmen (Sikorsky Archives, SikorskyArchives.com). Only a year later, the Army used the helicopter to rescue three passengers and the pilot of an airplane shot down by enemy lines (Sikorsky Archives, SikorskyArchives.com). Presently, all forms of military take advantage of the wonderful technology of rotorcraft. Thanks to the aid of military rotors, preservation of many lives is made possible.

A new advancement in the aeronautics field of study is the future amphibious tilt rotor. The amphibious tilt rotor is a new invention in not only aviation, but marine and terrain technology too. With this new development, saving lives will be its number one priority.

An array of M-22's land after a successful rescue mission <http://widescreenstuff.vndv.com/Military_Aircraft/default.html>.

The capabilities of the amphibious tilt rotor are endless. One key aptitude includes the ability to take off and land on any terrain, as well as any body of water. Unlike an airplane, the tilt rotor has the ability of a vertical take-off and landing, as well as a short departure and arrival. The V-22's leap ahead technology has revolutionized military air transport capabilities in a manner not since the introduction of helicopters more than 50 years ago (Chavanne, Navair.mil). The MV-22 Osprey is similar to the amphibious tilt rotor lacking one key feature: the ability to land on and take-off from water. Once it is airborne its engine nacelles can be rotated to convert the aircraft to a turboprop airplane capable of a high-speed, high-altitude, long-distant flights. The main difference that separates the Osprey from being amphibious is its lack of a flotation device secured beneath it. This might seem like a simple additive for the Osprey; however, the complexity of the design is much more advanced. Also, the Osprey only has the room to carry about 25 people, dissimilar to the amphibious tilt rotor, which will hold up to 50 passengers. Another rescue feature will include a water siphon, which will allow the tilt rotor to siphon water into an internal tank and expel it while airborne. The MV-22 Osprey has made a positive influence on many situations of distress, and has been a major help with assault, combat support, long-range special ops infiltration and exfiltration, transport, medevac, and most importantly search and rescue missions. Thankfully by creating the Osprey tilt rotor, we can now take steps to better a similar

A man fighting the raging sea is rescued by this helicopter <http://www.ttcelizabethton.edu/news/archived/swimmer.htm>.

creation that will have an even greater impact on search and rescue missions. Of course, following completion of the amphibious tilt rotor, it will be used for more than just search and rescue missions; although, this is main concern for its creation. Since we are unable to control the outcome of natural disaster, the amphibious tilt rotor will be the next closest stride to aid survival.

As aforementioned, rotorcraft has played a major role in providing service to those in times of desperate need. Many consider the Indian Ocean Tsunami in December of 2004 to be one of the deadliest quakes on earth. According to the U.S. Geological Survey (USGS) the earthquake was estimated to have released the energy of 23,000 Hiroshima-type atomic bombs (National Geographic News, NationalGeographic.com). Sadly, more than 150,000 people were either killed or declared missing (National Geographic News, NationalGeographic.com). Without delay, the Coast Guard and Navy were sent to aid all the victims of the tsunami. On January 4, the amphibious USS Bonhomme Richard assault ship arrived to assist the United States Marine Corps in providing food, medicine supplies, and fresh water daily (West, AviationToday.com). Meanwhile, pilots aboard various rotor vehicles navigated through the most constricted spots with staggering

A family stranded on the rooftop of their home is saved after Hurricane Katrina hit New Orleans, Louisiana <jesswundrun.blogspot.com/2007_08_01_archive.html >.

proficiency. With the assistance of the amphibious USS Bonhomme Richard assault ship and multiple rotor aircrafts, many people, young and old, were given a second chance. The invention of an amphibious tilt rotor would combine these two great means of rescue to accomplish the task at hand at a much faster rate. While the assault ship lacks the swiftness of the rotorcraft, the rotorcraft is absent in the ability to navigate on water. The combination of these two attributes would be astounding! The great mass of people that are saved due to carrying capacity assault ships would also be included in the amphibious tilt rotor, which would carry up to 50 passengers. Also, at traveling speeds of 300 kts, the amphibious tilt rotor would be able to transport 50 wounded civilians to the nearest hospital much faster, almost doubling the survival rate! Another example of how rotorcraft aids on the brink of a natural disaster is Hurricane Katrina. On August 2005, a massive hurricane struck the states of Louisiana, Alabama, and Mississippi leaving many people stranded and others crying out for help. Military officers and volunteers with helicopters rushed in to provide service to those in need and to help in any way possible. They landed on rooftops, parking garages, and other solid surfaces to transport victims to the nearest medical center. Thanks to many brave men and women, thousands of people were saved; and rotor aircrafts made that possible. Unfortunately, many innocent people still lost their life that horrible day as a result of drowning. As abovementioned, pilots were only able to land on solid surfaces because of tension build up caused by ditching and water impact (Wittlin, FFA.gov). With the amphibious tilt rotor thrown into play, all these limitations would be eliminated. The tilt rotor's amazing facility of landing on water, as well as the capability of siphoning water while airborne could help save a great portion of those abandoned at sea. The advancement of the tilt rotor would make prior impossible feats possible. The amphibious tilt rotor will be by far the best, most advanced form of technology of all rotorcrafts. However in

order to actually create this new invention, we will have to take ideas form current, similar aviation devices and partially combine those designs with other forms of marine transportation. Since this is going to be known as the amphibious tilt rotor, key word being amphibious, it must also be able to land-on and take-off from water. As previously stated, three critical concepts we must consider while designing this include: air travel, water landings, and a built in water siphon. The first objective of course is going to be air travel; thankfully we reached that goal of flying many years ago. Our next main focus is being able to land the rotorcraft on water. What is needed is some type of inflatable flotation devices built into the wheel compartments. This will allow the weight of the tilt rotor to be evenly distributed through each float, on the surface of the water. However consideration must be taken upon the fact that, if we are landing on ocean waters, then balancing issues must be addressed due to heavy waves. In order to survive intense water impact, a full sized flotation devise must separate the entire base of the rotorcraft from the water, while angling up sides on all ends of the device to keep the water from penetrating. Or, another idea would be to design the tilt rotor to be designed to equip a waterproof or water-resistant hull, like a boat, which can float directly on top of the water. The final major rotorcraft improvement for

This is an amphibious helicopter floats on water due to its waterproof hull body <http://www.terradaily.com/news/disastermanagement-05zzk.html>.

the amphibious tilt rotor is a built-in water siphon and water storage compartment. With this new unit, the amphibious tilt rotor will be able to transport water from an ocean or lake, and apply it to the scene of a fire, from directly above. This additive is a major feature that will help the overall purpose of the amphibious tilt rotor, which is to rescue and secure lives. Not only would the rotor be able to rescue lives but potentially act as a fire fighting device as well. With this new feature included in the amphibious tilt rotor, we may be able to preserve the building, forests, or other sites on fire.

In conclusion, it is evident of the impact an amphibious tilt rotor would have in our world today. With all the positive effects and successful rescue missions rotorcraft has helped to accomplish, there are still boundaries that have yet to have been crossed. Of course, there's always room for improvement. Engineers and technicians are laboring endlessly to create a masterpiece such as this and history has shown the vast improvements they have made to this point. As it should be, the main focus of this new innovation is to further improve the capabilities of rotor rescue operations, essentially saving lives. With innovative minds, compassion, and commitment to persist amid adversity, together we can make this vision a reality. Hopefully, this new amphibious tilt rotor will merely be a spark that starts the next generation of rotorcraft technology. On a related note for future rotorcrafts, while gravity is majorly effective on transportation in earth's atmosphere, by inventing some type of instrument that can control the gravitational pull in individual locations perhaps could completely replace the need for rotorcrafts in the future. Eventually, with the continuation of study in the science and technology field, we might reach a higher goal of developing actual models of what now can only be grasped through our imagination and dreams. However, if we take a brief look back on the history of previous rescue missions and compare past beneficial equipment to the helpful

machinery we use today, the results are essentially incomparable. Needless to say, by continuing on this successful path, the possibilities for future ideas are endless.

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